Chernobyl Nuclear Disaster Revisited

Part one of a series

By Roberta C. Barbalace

A Human Face

In May 1996 a colleague sent me an article from Chemical and Engineering News (C&EN) about the Chernobyl nuclear reactor accident. I set it aside, thoroughly intending to write about it at a later time. I might have totally forgotten about it had I not unexpectedly encountered a young man from Belarus who provided a real face and a real personality that I needed to identify with the catastrophe.

Blasa was a round faced lad probably about eleven years old visiting from Belarus. His English was about as fluent as my Russian was. Between us there were perhaps a couple of dozen words that we both understood. His host family explained that he was a survivor of Chernobyl and was visiting the United States through a project sponsored by a group of business men who wanted to give the children some relief from the stress that they experience daily as a result of the Chernobyl disaster. I had thought about possible increase in cancer and birth defects. Somehow, stress ten years after the accident never entered my mind. I started shuffling through my pile of potential articles and found the one that Jim Bley had sent. The facts were mind-boggling.

Chernobyl Disaster Recalled

At 1:23 AM on April 26, 1986, two explosions ripped through the Unit 4 reactor of the Chernobyl Nuclear Power Plant in the Ukraine. The reactor block and adjacent structure were wrecked by the initial explosion. Nearby buildings were ignited by burning graphite projectiles. Radioactive particles swept across the Ukraine, Belarus, the western portion of Russia and eventually spread across Europe and the whole Northern Hemisphere. The accident followed a safety experiment in which the plant was operated outside of its designed parameters at very low power and unfavorable cooling conditions.

The graphite fires continued to burn for several days despite the fact that thousands of tons of boron carbide, lead, sand and clay were dumped over the core reactor by helicopter. The fire eventually extinguished itself when the core melted, flowed into the lower part of the building and then solidified, sealing off the entry. About 71% of

the radioactive fuel in the core (about 135 metric tons) remained uncovered for about 10 days until cooling and solidification took place. 135,000 people were evacuated from a 30-km radius exclusion zone. Clean up involved some 800,000 people. The radioactivity released was estimated to be about two hundred times that of the combined releases in the bombing of Hiroshima and Nagasaki. Millions of people were exposed to the radiation in varying doses.

Health Consequences of the Chernobyl Disaster

Compulsory health monitoring was provided to those who lived and worked in the heavily contaminated area. Health monitoring was also provided for more than 4.5 million people who were exposed to lower levels of radiation. Still, the available information on the direct health effects of the catastrophe are sketchy at best.

Twenty different radionuclides with half-lives varying from 8 days to 24,400 years were released into the atmosphere during the ten day period following the explosion. The contaminants include idiodine-131, cesium-134 and -137 and several plutonium isotopes. There were 444 workers at the site at the time of the accident. Of the 300 admitted to hospitals, 134 were diagnosed with acute radiation syndrome (ARS). Only 45 of these individuals have died to date, though the survivors still suffer with emotional and sleep disturbances and 30% have gastrointestinal, cardiovascular and immuno-function disorders. In Belarus alone 2.2 million people including 600,000 juveniles and children have been exposed to the prolonged impact of long-lived radionuclides. A total of 415 settlements have been evacuated, and the 130,000 residents resettled, making monitoring of them difficult.

The actual death toll due to this catastrophe is hard to determine. Greenpeace Ukraine estimates the total number to be about 32,000. Some estimates are higher, many are much lower. The rate of thyroid cancer in children up to the age of 15 has increased 200 fold in Gomel Oblast, Belarus since the accident. At least 90% of these are curable, but the number of cases is expected to increase, especially in children like Blasa who were younger than three at the time of the release. Thyroid cancer is due to inhalation of radioactive iodine or ingestion from drinking milk from cows that have eaten grass that is contaminated with radioactive particles. Iodine-134 is absorbed and concentrated (biointensified) in the milk. When humans drink the milk, the iodine-134 becomes incorporated almost exclusively in the thyroid gland. Many diets in the fall-out affected area of the former Soviet Union are typically deficient in iodine. Individuals who had low levels of iodine in their diet incorporated large quantities of the radioactive iodine into their system as their bodies attempted to compensate for the deficiency. At the moment few republics are reporting a rise in

leukemia, a condition which would have been expected to increase. It is possible that the actual rise in incidents of the disease is masked by the mass resettlement into other unaffected areas after the accident. This may have resulted in skewed results since any increase in the rate of leukemia would be averaged over a larger population of individuals, many of whom had not been exposed.

The incidences of birth defects have increased in heavily contaminated areas. A condition known as "minisatellite mutation" in the Mogilev district of Belarus is "unusually high."

Most genetic mutations resulting from exposure to radiation are recessive and are not likely to be expressed until the individuals affected have grandchildren. The mutation will be fully manifested when two people carrying the same mutant gene marry and produce a child who receives the identical mutant gene from each parent (a one-in-four chance for each child they produce). Radiation effects are dependent upon both level and time of exposure and some individuals continue to be exposed. As a result many effects of radiation on an exposed individual may not be manifested for years to come. Madame Curie reportedly worked with radioactive materials for years before she finally succumbed to its effects. Cancer may take many years to develop after exposure to a carcinogen.

The secondary effects of the accident are readily obvious. Millions of people are suffering from mental and emotional illness and these conditions lead to disturbances of the physical kind, including digestive disorders, high blood pressure, heart conditions and more generally sleeplessness and alcoholism. General living conditions in the three affected republics are substandard. The economy is deteriorating and health services are experiencing total collapse. People are malnourished, and diseases like tuberculosis are on the increase. Some of this economic depression is due to the accident, and some is a result of the general economic situation in the former Soviet Union as a whole. The immediate problems are more important to them than diseases that will not have a major impact until some time in the future. As a result, leukemia, thyroid cancer and birth defects must take a back seat to more pressing issues, such as basic survival. Extensive studies will be necessary in order to determine the total impact of the Chernobyl disaster and approach a solution intelligently.

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Part two of a series

By Roberta C. Barbalace

Could it be that human invasion has a greater impact on the environment than the most catastrophic nuclear accident in the 20th century?

In 1986 the Chernobyl accident contaminated 125,000 square miles of land in Belarus, Russia and Ukraine with radionucleotides including cesium-137, strontium-90 and plutonium-239. It is too early to determine the long-term effects of the radioactive contaminants on the various affected habitats, because genetic changes are often not expressed in a general population for two or three generations. From early observations, however, the prognosis is much more promising than had originally been expected.

About 40% of the contaminated area was used for agriculture. The remainder was forest, bodies of water and urban centers. Plants and animals living in the 30-km exclusion zone received the highest level of radiation. Since radionucleotides migrate very slowly in soil, the radiation level in this region remains high. In Belrus 2,640 sq. km of farmland and 1,900 sq. km of forest have been taken out of use by humans forever; so predicted Igor V. Rolevich, Belarus first deputy minister for emergencies.

The Chernobyl accident took place during the growing season. It took only two weeks for the conifers to suffer significant damage from exposure. Initially many trees suffered sever damage to reproductive tissue.

Within three years of the accident, the trees had regained their reproductive functions. The forests have begun to thrive. Areas within the heart of the exclusion zone have the largest density of animals as well as the greatest diversity. Since people and their livestock do not enter the exclusion zone, there is not much overgrazing, no fires and no destruction. The grass is very deep and the habitat is doing very well. The area outside the exclusion zone has been so severely overgrazed by cattle that there is little grass. In addition, the trees have been cut for firewood, a stress factor that has not affected the exclusion zone.

One must avoid the temptation to become too overly optimistic about the rapid recovery of the contaminated area. Currently there is no standard by which to predict the long-term effects on populations, species or ecosystems.

Contamination of the soil by radionucleotides with long half-lives such as cesium-137 is a particular problem for the local residents near the Chernobyl Nuclear Reactor. These radionucleotides remain in the soil for a long while, is taken up by plants and transferred to the milk and meat products of cattle that graze the area. Human exposure could have been reduced by imposing strict countermeasures immediately following the release. Had local residents not worked in the field, or eaten fresh vegetables, and had they kept their livestock from eating the contaminated forage. Such measures need to be taken immediately, however, and they were not. Very specific countermeasures applied immediately can have a great bearing on the long term effects of a radioactive release. Changing the type of crop planted (each species has a different rate at which it absorbs specific chemical elements or compounds) or adding chemicals such as lime or potassium fertilizers can protect the population. In order for this to happen, residents have to be trained to respond, and the needed supplies must be readily available. No emergency procedure was in place for dealing with the catastrophe.

It is interesting that the water supply is not nearly as contaminated as the soil. The radionucleotides tend to settle out with time. Aquatic habitats also tend to be more tolerant of radioactive contamination. There is no evidence of any long term effects to the populations in the water near the nuclear reactor's cooling pond, which was the most contaminated body of water in the exclusion zone.

While the groundwater has not been contaminated to date, the Sarcophagus, which

was built around Reactor Unit 4 is crumbling and there are many sites where radiation contaminated equipment were dumped.

While the environment in the exclusion zone seems to have recovered, it still has to deal with long term effects (such as genetic mutations, which may not surface for a few generations) and the real threat of another release of radioactivity should the integrity of the sarcophagus continue to disintegrate.

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